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TITLE: **Heat pump** type heat supply system controls to **switch** **four-way valve** after changing **flow rate** and differential pressure of compressor to values within appropriate limits

PATENT-ASSIGNEE: HITACHI LTD[HITA]

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BASIC-ABSTRACT:

NOVELTY - A controller (9) which judges if the differential pressure of a compressor (1) is within an appropriate range by a calculation from the outputs of the sensors (7,8) which detect the suction and discharge pressures, controls to **switch a four-way valve** (2) after changing the **flow rate** and differential pressure of the compressor to values within appropriate limits.

DETAILED DESCRIPTION - An outdoor heat exchanger (3) which exchanges heat

between outdoor air and a refrigerant flowing into it, an expansion valve (4)
and an indoor heat exchanger (5) which exchanges heat between a fluid and the
refrigerant flowing into it, are connected with the compressor through the
four-way valve. The fluid flowing in the indoor heat exchanger is cooled with
the refrigerant flows from the outdoor heat exchanger to the indoor heat
exchanger and heated with the refrigerant flow is reversed with the switching
of the four-way valve.

USE - For alternately performing the cooling and the heating of fluid such as
water for supplying cold and hot water for an air conditioner, etc., switchably.

ADVANTAGE - The crack of a valve and a stoppage of valve at an intermediate
position due to a damage can be prevented, since a **four-way valve is switched**
with a controller only after changing the **flow rate** and differential pressure
of a compressor to values within appropriate limits.

DESCRIPTION OF DRAWING(S) - The figure shows the block diagram of **heat pump**
type heat supply system. (Drawing includes non-English language text).

Compressor 1

Four-way valve 2

Outdoor heat exchanger 3

Expansion valve 4

Indoor heat exchanger 5

Sensors 7,8

Controller 9

CHOSEN-DRAWING: Dwg.1/8

TITLE-TERMS: **HEAT PUMP** TYPE HEAT SUPPLY SYSTEM CONTROL **SWITCH FOUR WAY VALVE**

AFTER CHANGE **FLOW RATE** DIFFERENTIAL PRESSURE COMPRESSOR VALUE

APPROPRIATE LIMIT

DERWENT-CLASS: Q74 Q75 X27

EPI-CODES: X27-F02B;

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a heat pump type heat feeder, and relates to the heat pump type heat feeder which can switch cold water and warm water to a conditioner etc., and can supply them especially.
[0002]
[Description of the Prior Art] An air side heat exchanger, a pressure reducer, and a water side heat exchanger are prepared in a heat pump type heat feeder, an air side heat exchanger performs heat exchange between a refrigerant and the open air, and a water side heat exchanger performs heat exchange between the water which carries out conduction of the interior to a refrigerant. And if the refrigerant from a compressor is poured in order of an outdoor side heat exchanger, a pressure reducer, and an interior-of-a-room side heat exchanger, it will be cooled and the water which carries out conduction of the inside of a water side heat exchanger will be supplied as cold water. Moreover, if the refrigerant from a compressor is conversely poured in order of an interior-of-a-room side heat exchanger, a pressure reducer, and an outdoor side heat exchanger, the water which carries out conduction of the inside of a water side heat exchanger will be warmed, and will be supplied as warm water. It is performed by switching the four-way switching valve attached in discharge-side piping of a compressor whether it is made cold water or it is made warm water.
[0003] When a four-way switching valve is switched and the valve element has stopped at the mid-position without a four-way switching valve's switching normally, equipment cannot be operated normally but it cannot but stop by the way, suspending operation.
[0004] Although it is a technique about an air conditioner, when a four-way switching valve is switched, judging whether the four-way switching valve switched normally is proposed by JP,8-128749,A by detecting the piping temperature before and behind the change-over, and seeing the temperature gradient before and behind a change-over, for example. However, when having not switched normally only by judging whether the four-way switching valve switched normally, normal operation can be continued and operation of a conditioner must be stopped after all.
[0005] So, the air conditioner which prevented that the valve element of a four-way switching valve stopped at the mid-position is proposed by JP,5-322355,A. In this air conditioner, a four-way switching valve changes the flow of a refrigerant using the differential pressure the discharge side of a compressor, and by the side of intake, and bypasses a four-way switching valve between the discharge side of a compressor, and an intake side, and the bypass circuit is prepared. And since the closing motion valve is attached in the bypass circuit, the differential pressure which will start a four-way switching valve if this closing motion valve is opened in starting of a compressor and coincidence at the time of heating operation becomes small and the valve element of a four-way switching valve stops at the mid-position, it has prevented that a valve element stops at the mid-position as it opens, after delaying said closing motion valve for 10 seconds.
[0006]

[Problem(s) to be Solved by the Invention] Here, even if it applies opening after delaying a closing motion valve for 10 seconds as mentioned above to a heat pump type heat feeder, the malfunction of a four-way switching valve cannot be lost completely. That is, after delaying a closing motion valve for 10 seconds, even if it makes it open since big variation is in the differential pressure the discharge side of a compressor, and by the side of intake at the time of starting, possibility of not restricting a four-way switching valve operating normally, but stopping at the mid-position is large.
[0007] Moreover, when big variation is in the differential pressure the discharge side of a compressor, and by the side of intake as mentioned above, at the time of a change-over of a four-way switching valve, the big force joins a valve element and there is also a possibility that a valve element may break.
[0008] The purpose of this invention is to offer the heat pump type heat feeder which can switch a four-way switching valve proper.
[0009]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention A compressor, the 1st heat exchanger, a pressure reducer, The 2nd heat exchanger and a four-way switching valve are equipped with the refrigerating cycle by which sequential connection was made. The 1st heat exchanger performs heat exchange between the air which flows this heat exchanger outside, and the refrigerant which circulates through the inside of a refrigerating cycle. The 2nd heat exchanger performs heat exchange between the fluid which carries out conduction of the inside of this heat exchanger, and said refrigerant. Said fluid is cooled and supplied, when a four-way switching valve is switched and said refrigerant is poured in order of the 1st heat exchanger, a pressure reducer, and the 2nd heat exchanger. In the heat pump type heat feeder which said fluid is warmed and is supplied when a four-way switching valve is switched conversely and said refrigerant is poured in order of the 2nd heat exchanger, a pressure reducer, and the 1st heat exchanger While incorporating a detection result from a pressure detection means to detect the discharge-side pressure and intake lateral pressure of a compressor, and a pressure detection means and calculating the differential pressure of the discharge-side pressure of a compressor, and intake lateral pressure After it judges whether said differential pressure is contained in the proper range set up beforehand in case a four-way switching valve is switched, it changes the discharge quantity of a compressor when [proper] out of range, and said differential pressure goes into proper value within the limits, it is characterized by having the control means which switches a four-way switching valve.
[0010] In case a four-way switching valve is switched according to the above-mentioned configuration, if the differential pressure of the discharge pressure of a compressor and intake lateral pressure judged whether it would go into the proper range set up beforehand and is contained in the proper range, a four-way switching valve will be switched immediately, but a control means switches a four-way switching valve, after it changes the discharge quantity of a compressor and differential pressure goes into proper value within the limits, when [proper] out of range. Since it is avoidable that big differential pressure joins a four-way switching valve by this, it can prevent a crack and damage occurring in a valve element. Furthermore, it can also be prevented differential pressure being too small and the valve element of a four-way switching valve stopping at the mid-position.
[0011] A control means decreases the discharge quantity of a compressor, when it is over the upper limit of the proper range, when differential pressure is under the lower limit of the proper range, it makes the discharge quantity of a compressor increase, and after differential pressure goes into proper value within the limits, it is actually controlled to switch a four-way switching valve.
[0012] The proper range is determined from the life property of the count of a change-over of the four-way switching valve which becomes settled according to differential pressure.
[0013] Moreover, even if it makes the discharge quantity of a compressor decrease or increase, when said differential pressure does not enter within proper limits, while stopping a compressor, it consists of this inventions so that an alarm display may be carried out. In this case, it is made to reboot a compressor when differential pressure goes into the proper range.
[0014] Furthermore, after switching a four-way switching valve, a detection result is incorporated from a pressure detection means, and the differential pressure of the discharge-side pressure of a compressor

and intake lateral pressure is calculated, and when the differential pressure is outlying observation, it can also constitute so that a compressor may be stopped. In this case, a compressor is stopped, while rebooting a compressor after predetermined time progress, said differential pressure is calculated, and a compressor is stopped when that differential pressure is outlying observation. Moreover, when starting and a halt of a compressor are repeated the number of predetermined times, it is made to perform an alarm display.

[0015]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained according to a drawing.

(Gestalt 1 of operation) Drawing 1 is the block diagram of the heat pump type heat feeder concerning this invention. As shown in drawing, sequential connection of a compressor 1, a four-way switching valve 2, the 1st heat exchanger 3, an expansion valve 4, the 2nd heat exchanger 5, and the four-way switching valve 2 is made, and the refrigerating cycle is formed. That is, the discharge side of a compressor 1 is connected to a four-way switching valve 2 through the refrigerant passage L1, and the 1st heat exchanger 3 is connected to the 1st heat exchanger 3 for the four-way switching valve 2 through the refrigerant passage L3 at the expansion valve 4 through the refrigerant passage L2, respectively. Moreover, the four-way switching valve 2 is connected [the expansion valve 4] to the 2nd heat exchanger 5 for the 2nd heat exchanger 5 through refrigerant passage L6 at the compressor's 1 intake side at the four-way switching valve 2 through the refrigerant passage L5 through the refrigerant passage L4, respectively.

[0016] The 1st heat exchanger 3 is a heat exchanger by the side of a heat source, and air cooling is carried out with a cooling fan 6. Moreover, the 2nd heat exchanger 5 is a heat exchanger by the side of use, and inhalant canal 5A and excurrent canal 5B are attached, the water which flowed from inhalant canal 5A carries out conduction of the interior, and it flows out of excurrent canal 5B after that.

[0017] A refrigerant circulates through the inside of the above-mentioned refrigerating cycle, at the time of operation (henceforth cold-water supply operation) which cools the water which carries out conduction of the inside of the 2nd heat exchanger 5, a refrigerant flows like the continuous-line arrow head of drawing, and a refrigerant flows like the broken-line arrow head of drawing at the time of operation (henceforth warm water supply operation) to warm. Moreover, as for a four-way switching valve 2, the passage of a refrigerant where it flows is switched like a broken line like a continuous line, respectively at the time of warm water supply operation at the time of cold-water supply operation.

[0018] Moreover, the pressure sensor 8 with which the pressure sensor 7 which detects the discharge-side refrigerant pressure force of a compressor 1 detects the intake side refrigerant pressure force of a compressor 1 to refrigerant passage L6 is formed in the refrigerant passage L1, respectively, and the control unit 9 into which the detecting signal in these pressure sensors 7 and 8 is inputted is installed.

[0019] In the above-mentioned configuration, at the time of cold-water supply operation, after the gas refrigerant of elevated-temperature high pressure compressed with the compressor 1 is led to a four-way switching valve 2 through the refrigerant passage L1 and flows this four-way switching valve 2 along the passage of a continuous line, it is led to the 1st heat exchanger 3 through the refrigerant passage L2. In the 1st heat exchanger 3, heat exchange of the gas refrigerant of elevated-temperature high pressure is carried out to the air ventilated by the cooling fan 6, it is condensed, and turns into liquid cooling intermediation of elevated-temperature high pressure. Liquid cooling intermediation of that elevated-temperature high pressure is led to an expansion valve 4 through the refrigerant passage L3, it is decompressed by this expansion valve 4, turns into a two phase refrigerant of low-temperature low voltage, and is further led to the 2nd heat exchanger 5 through the refrigerant passage L4. And in the 2nd heat exchanger 5, heat exchange of the two phase refrigerant of low-temperature low voltage is carried out to the water which carries out conduction of the inside of the 2nd heat exchanger 5, and it cools the water. Thereby, cold water can be obtained from the 2nd heat exchanger 5.

[0020] The two phase refrigerant of low-temperature low voltage which carried out heat exchange to water by the 2nd heat exchanger 5 evaporates, turns into a gas refrigerant of low-temperature low voltage, is led to a four-way switching valve 2 through the refrigerant passage L5, after passing this

four-way switching valve 2, is returned to a compressor 1 through refrigerant passage L6, and is again compressed with a compressor 1.

[0021] At the time of warm water supply operation, after the gas refrigerant of elevated-temperature high pressure compressed with the compressor 1 is led to a four-way switching valve 2 through the refrigerant passage L1 and flows this four-way switching valve 2 along the passage of a broken line, it is led to the 2nd heat exchanger 5 through the refrigerant passage L5. In the 2nd heat exchanger 5, heat exchange of the gas refrigerant of elevated-temperature high pressure is carried out to the water which carries out conduction of the inside of the 2nd heat exchanger 5, and it warms the water. Thereby, warm water can be obtained from the 2nd heat exchanger 5.

[0022] The gas refrigerant of elevated-temperature high pressure which carried out heat exchange to water by the 2nd heat exchanger 5 is condensed, and turns into liquid cooling intermediation of elevated-temperature high pressure. Liquid cooling intermediation of that elevated-temperature high pressure is led to an expansion valve 4 through the refrigerant passage L4, it is decompressed by this expansion valve 4, turns into a two phase refrigerant of low-temperature low voltage, and is further led to the 1st heat exchanger 3 through the refrigerant passage L3. In the 1st heat exchanger 3, heat exchange of the two phase refrigerant of low-temperature low voltage is carried out to the air ventilated by the cooling fan 6, it evaporates, and turns into a gas refrigerant of low-temperature low voltage. And the gas refrigerant of that low-temperature low voltage is led to a four-way switching valve 2 through the refrigerant passage L2, is returned to a compressor 1 through refrigerant passage L6 after passing this four-way switching valve 2, and is again compressed with a compressor 1.

[0023] Drawing 2 and drawing 3 are the configurations and drives of a four-way switching valve 2, drawing 2 shows the condition at the time of cold-water supply operation, and drawing 3 shows the condition at the time of warm water supply operation, respectively. as shown in drawing 2 and drawing 3 , passage connection 2A, 2B, 2C, and 2D prepare in a four-way switching valve 2 -- having -- passage connection 2A -- the refrigerant passage L1 -- passage connection 2C is connected to refrigerant passage L6, and passage connection 2D is connected to the refrigerant passage L5 for passage connection 2B in the refrigerant passage L2, respectively. Moreover, cross-section semicircle-like valve element 2E is prepared in that interior free [migration] at a four-way switching valve 2, and if it connects with the pistons 2F and 2G arranged at those both sides and Pistons 2F and 2G move the interior of a four-way switching valve 2 to the longitudinal direction of drawing, this valve element 2E will be interlocked with it, and will move to a longitudinal direction. By this, like drawing 2 , passage connection 2A can be connected to passage connection 2D, passage connection 2C can be connected to passage connection 2B, and like drawing 3 , passage connection 2A can be connected to passage connection 2B, and passage connection 2C can be connected to passage connection 2D.

[0024] Moreover, the passage change-over control valve 10 is formed, and Pistons 2F and 2G move the interior of a four-way switching valve 2 to the longitudinal direction of drawing by carrying out change-over actuation of this passage change-over control valve 10, and transmitting the pressure pressure room 2H of a four-way switching valve 2, pressure room 2I, or in passage connection 2C for the pressure in passage connection 2A to pressure room 2H or pressure room 2I.

[0025] At the time of cold-water supply operation, the passage change-over control valve 10 is switched like drawing 2 . Since the gas refrigerant of low-temperature low voltage with which the gas refrigerant of elevated-temperature high pressure compressed into passage connection 2A by the compressor 1 is attracted by passage connection 2C with a compressor 1 is flowing, in pressure room 2I, pressure room 2H becomes the high-tension side with the low-tension side, Pistons 2F and 2G are pushed leftward [of drawing], and valve element 2E also moves them in this direction. By this, the gas refrigerant of elevated-temperature high pressure flows from passage connection 2A to passage connection 2D, and the gas refrigerant of low-temperature low voltage flows from passage connection 2B to passage connection 2C.

[0026] At the time of warm water supply operation, the passage change-over control valve 10 is switched like drawing 3 . In this case, in pressure room 2I, pressure room 2H becomes the low-tension side with the high-tension side, Pistons 2F and 2G are pushed rightward [of drawing], and valve

element 2E also moves them in this direction. By this, the gas refrigerant of elevated-temperature high pressure flows from passage connection 2A to passage connection 2B, and the gas refrigerant of low-temperature low voltage flows from passage connection 2D to passage connection 2C.

[0027] Drawing 4 shows the operation flow chart of the heat pump type heat feeder in the gestalt of this operation. A compressor 1 is equipped with the function which switches discharge quantity gradually with 50%, 75%, and 100%. Here, in case a refrigerating cycle is switched to cold-water supply operation from warm water supply operation from cold-water supply operation, or warm water supply operation, a pressure sensor 7 detects the discharge-side pressure Pd of a compressor 1, and a pressure sensor 8 detects the intake lateral pressure Ps. The detecting signal in pressure sensors 7 and 8 is inputted into a control unit 9, and a control unit 9 calculates differential pressure deltaP=Pd-Ps based on the inputted detecting signal. And a control unit 9 decreases the discharge quantity of a compressor 1 to 75%, when it judges whether differential pressure deltaP is contained in the proper range and differential pressure deltaP is over 0.075MPa(s). Consequently, a leeway is given in the heating area of heat exchangers 3 and 5, the discharge-side pressure Pd declines, the intake lateral pressure Ps rises, and differential pressure deltaP becomes small. And after predetermined time progress, differential pressure deltaP is calculated, and again, if it is 0.075 or less MPas, a four-way switching valve 2 will be switched. If the discharge quantity of a compressor 1 is decreased to 50%, differential pressure deltaP is made small and it is set to 0.075 or less MPas when it is still over 0.075MPa(s), a four-way switching valve 2 will be switched.

[0028] On the other hand, when differential pressure deltaP is less than 0.035 MPas, if differential pressure deltaP is made to increase and it is set to 0.035 or more MPas by making the discharge quantity of a compressor 1 increase with 75% and 100%, a four-way switching valve 2 will be switched.

[0029] In addition, even if it makes the discharge quantity of a compressor 1 decrease or increase, when differential pressure deltaP does not go within the limits of 0.035 MPa<=delta P<=0.075MPa, an alarm display is carried out while stopping a compressor 1.

[0030] Moreover, differential pressure deltaP after switching a four-way switching valve 2 is calculated, and when the differential pressure deltaP is outlying observation, for example, 0-0.02MPa, the valve element of a four-way switching valve 2 judges that a halt or the switch of a valve element to the mid-position is poor, and suspends operation of a refrigerating cycle.

[0031] If it passes predetermined time from the halt, and re-operation was resumed and differential pressure deltaP is over 0.02MPa(s), operation will be continued and, as for the case of 0-0.02MPa, operation will be stopped. And an alarm display when the count of predetermined is repeated, that abnormalities are in a four-way switching valve 2 about a restart and halt of operation is performed, and the drop dead halt of the refrigerating cycle operation is carried out.

[0032] As mentioned above, with the gestalt of this operation, when differential pressure deltaP while adjusting the discharge quantity of a compressor 1 within the limits of 0.035 MPa<=delta P<=0.075MPa so that a four-way switching valve 2 may be switched, after differential pressure deltaP switches a four-way switching valve 2 is outlying observation, after stopping operation and carrying out count of predetermined re-operation, an alarm display is carried out and operation is stopped.

[0033] Drawing 5 shows the relation between differential pressure deltaP and the life by the count of a change-over at the time of actuation of a four-way switching valve. If differential pressure deltaP is large as shown in drawing, a four-way switching valve will tend to break down, even if the count of a change-over is small, and a life will fall. On the contrary, if differential pressure deltaP is small, a four-way switching valve cannot break down easily, even if the count of a change-over is large, and will serve as reinforcement. So, in view of mechanical and life specification on the strength of a four-way switching valve, it controls by the gestalt of this operation to switch a four-way switching valve in a proper differential region.

[0034] Since according to the gestalt of this operation proper differential pressure is applied to a valve element in case a four-way switching valve 2 is switched by controlling the differential pressure which joins a four-way switching valve 2, the crack of a valve element, breakage, etc. can be prevented and reinforcement of a four-way switching valve 2 can be attained.

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[0035] moreover, by asking for the differential pressure after switching a four-way switching valve 2, if it could detect whether the valve element of a four-way switching valve 2 would have stopped to the mid-position and the valve element has stopped to the mid-position, operation will be suspended -- making -- ********** -- since -- a refrigerating cycle is protected by resuming operation automatically, and it leads to the improvement in dependability of the whole system.
[0036] In addition, although differential pressure deltaP was made to switch the four-way switching valve 2 within the limits of 0.035 MPa<=delta P<=0.075MPa with the gestalt of this operation, differential pressure deltaP can be changed by of about [which] the count of a change-over is made into a life.
[0037] Moreover, the fluids which carry out conduction of the inside of the 2nd heat exchanger 5 may be not only water but other fluids.
[0038] (Gestalt 2 of operation) Drawing 6 shows the gestalt 2 of operation of this invention. A compressor 1 consists of gestalten of this operation so that predetermined discharge quantity can be changed continuously. Other configurations are the same as the gestalt 1 of operation. That is, the configuration of a refrigerating cycle is the same as what was shown in drawing 1 , and the same as what also showed the configuration of a four-way switching valve 2 to drawing 2 and drawing 3 R> 3.
[0039] the case where the control unit 9 calculated differential pressure deltaP which switches a four-way switching valve 2 with the gestalt of this operation, and differential pressure deltaP is over 0.075MPa(s) -- the discharge quantity of a compressor 1 -- the specified quantity -- for example, it is made to decrease 5% (in addition, the specified quantity is any value) And if differential pressure deltaP was calculated and it is over 0.075MPa again after predetermined time progress, discharge quantity will be decreased 5% similarly, and it will adjust so that differential pressure deltaP may be set to 0.075 or less MPas.
[0040] Moreover, also when differential pressure deltaP is less than 0.035 MPas, the increment in the specified quantity of the discharge quantity of a compressor 1 is carried out similarly, and if differential pressure deltaP is set to 0.035 or more MPas, a four-way switching valve 2 will be switched.
[0041] According to the gestalt of this operation, it can prevent that a valve element stops in the mid-position in the crack of the valve element of a four-way switching valve 2, prevention of breakage, and a list like the gestalt 1 of operation by detecting the differential pressure which joins a four-way switching valve 1, and carrying out specified quantity change of the discharge quantity of a compressor 1. Furthermore, with the gestalt of this operation, since the discharge quantity from a compressor 1 is continuously controlled by the specified quantity, it is not necessary to add the capacity limit beyond the need of being based on reduction delay. That is, the capacity fall which supplies cold water or warm water can be suppressed to the minimum.
[0042] (Gestalt 3 of operation) Next, the gestalt 3 of operation is explained using drawing 7 . A compressor 1 is equipped with the function which switches discharge quantity gradually with 50%, 75%, and 100% like the case of the gestalt 1 of operation. Here, in case it switches to defrosting operation from warm water supply operation, a pressure sensor 7 detects the discharge-side pressure Pd of a compressor 1, and a pressure sensor 8 detects the intake lateral pressure Ps. The detecting signal in pressure sensors 7 and 8 is inputted into a control unit 9, and a control unit 9 calculates differential pressure deltaP=Pd-Ps. And a control unit 9 changes the discharge quantity of a compressor 1, when differential pressure deltaP judges whether it is below deltaPmax and is over deltaPmax (for example, discharge quantity is decreased to 75%). After a certain fixed time amount progress, again, differential pressure deltaP is calculated, and if it is below deltaPmax, a four-way switching valve 2 will be switched. If it is over deltaPmax, the discharge quantity of a compressor 1 will still be changed further (for example, discharge quantity is decreased to 50%). And if it becomes below deltaPmax, a four-way switching valve 2 will be switched.
[0043] Moreover, since differential pressure deltaP after switching a four-way switching valve 2 is calculated, and the valve element of a four-way switching valve 2 is judged that a halt or the switch of a valve element to the mid-position is poor when the differential pressure deltaP is under outlying-observation deltaPmin, operation (namely, operation of a compressor 1) of a refrigerating cycle is

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suspended.
[0044] If it passes predetermined time from the halt, re-operation is resumed, if differential pressure deltaP is more than deltaPmin, operation will be continued, and operation will be stopped if it is under deltaPmin. And an alarm display when the count of predetermined is repeated, that abnormalities are in a four-way switching valve 2 about a restart and halt of operation is performed, and the drop dead halt of the refrigerating cycle operation is carried out. In addition, as for the example of deltaPmax and deltaPmin, drawing 5 is shown.
[0045] As mentioned above, with the gestalt of this operation, the discharge quantity of a compressor is adjusted so that a four-way switching valve may be switched for differential pressure deltaP within the limits of delta Pmin-delta Pmax, when differential pressure deltaP is outlying observation, after stopping operation and carrying out count of predetermined re-operation, an alarm display is carried out and operation is stopped. According to the gestalt of this operation, the same effectiveness as the gestalt 1 of operation can be acquired.
[0046] (Gestalt 4 of operation) Next, the gestalt 4 of operation is explained using drawing 8 . A compressor 1 can change predetermined discharge quantity now continuously like the gestalt 2 of operation.
[0047] With the gestalt of this operation, when differential pressure deltaP which switches a four-way switching valve 2 is calculated and differential pressure deltaP is over deltaPmax, a control unit 9 changes the discharge quantity of a compressor 1 to the specified quantity, for example, is decreased 5%. And after predetermined time progress, differential pressure deltaP is calculated, again, if it is below deltaPmax, a four-way switching valve 2 will be switched, if it is over deltaPmax, specified quantity change (reduction) of the discharge quantity of a compressor 1 will be carried out, and differential pressure deltaP will be made small, and it adjusts repeatedly so that it may become below deltaPmax. According to the gestalt of this operation, the same effectiveness as the gestalt 2 of operation can be acquired.
[0048]
[Effect of the Invention] As explained above, according to this invention, it can also be prevented by calculating the differential pressure which switches a four-way switching valve, and switching a four-way switching valve in the state of proper differential pressure that can prevent the crack of a valve element and breakage and a valve element stops to the mid-position. Consequently, the dependability of a four-way switching valve can improve and reinforcement can be attained.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] A compressor, the 1st heat exchanger, a pressure reducer, the 2nd heat exchanger, and a four-way switching valve are equipped with the refrigerating cycle by which sequential connection was made. Said 1st heat exchanger performs heat exchange between the air which flows this heat exchanger outside, and the refrigerant which circulates through the inside of said refrigerating cycle. Said 2nd heat exchanger performs heat exchange between the fluid which carries out conduction of the inside of this heat exchanger, and said refrigerant. Said fluid is cooled and supplied, when said four-way switching valve is switched and said refrigerant is poured in order of said 1st heat exchanger, said pressure reducer, and said 2nd heat exchanger. In the heat pump type heat feeder which said fluid is warmed and is supplied when said four-way switching valve is switched conversely and said refrigerant is poured in order of said 2nd heat exchanger, said pressure reducer, and said 1st heat exchanger While incorporating a detection result from a pressure detection means to detect the discharge-side pressure and intake lateral pressure of said compressor, and said pressure detection means and calculating the differential pressure of the discharge-side pressure of said compressor, and intake lateral pressure It judges whether in case said four-way switching valve is switched, said differential pressure is contained in the proper range set up beforehand. When [proper] out of range The heat pump type heat feeder characterized by having the control means which switches said four-way switching valve after it changes the discharge quantity of said compressor and said differential pressure goes into proper value within the limits.
[Claim 2] A compressor, the 1st heat exchanger, a pressure reducer, the 2nd heat exchanger, and a four-way switching valve are equipped with the refrigerating cycle by which sequential connection was made. Said 1st heat exchanger performs heat exchange between the air which flows this heat exchanger outside, and the refrigerant which circulates through the inside of said refrigerating cycle. Said 2nd heat exchanger performs heat exchange between the fluid which carries out conduction of the inside of this heat exchanger, and said refrigerant. Said fluid is cooled and supplied, when said four-way switching valve is switched and said refrigerant is poured in order of said 1st heat exchanger, said pressure reducer, and said 2nd heat exchanger. In the heat pump type heat feeder which said fluid is warmed and is supplied when said four-way switching valve is switched conversely and said refrigerant is poured in order of said 2nd heat exchanger, said pressure reducer, and said 1st heat exchanger While incorporating a detection result from a pressure detection means to detect the discharge-side pressure and intake lateral pressure of said compressor, and said pressure detection means and calculating the differential pressure of the discharge-side pressure of said compressor, and intake lateral pressure It judges whether in case said four-way switching valve is switched, said differential pressure is contained in the proper range set up beforehand. The control means which switches said four-way switching valve after decreasing the discharge quantity of said compressor, the case of under the lower limit of the proper range making the discharge quantity of said compressor increase and said differential pressure's going into proper value within the limits, when it is over the upper limit of the proper range, The heat pump type heat feeder characterized by preparation ******.
[Claim 3] It is the heat pump type heat feeder characterized by what it opts for from the life property of

the count of a change-over of said four-way switching valve that said proper range becomes settled according to said differential pressure in a heat pump type heat feeder according to claim 1 or 2.
[Claim 4] It is the heat pump type heat feeder which sets to a heat pump type heat feeder according to claim 1 or 2, and is characterized by carrying out the alarm display of it while said control means stops said compressor, when said differential pressure does not enter within proper limits, even if it makes the discharge quantity of said compressor decrease or increase.
[Claim 5] Said control means is a heat pump type heat feeder which will be characterized by rebooting said compressor if said differential pressure goes into the proper range in a heat pump type heat feeder according to claim 4.

[Translation done.]

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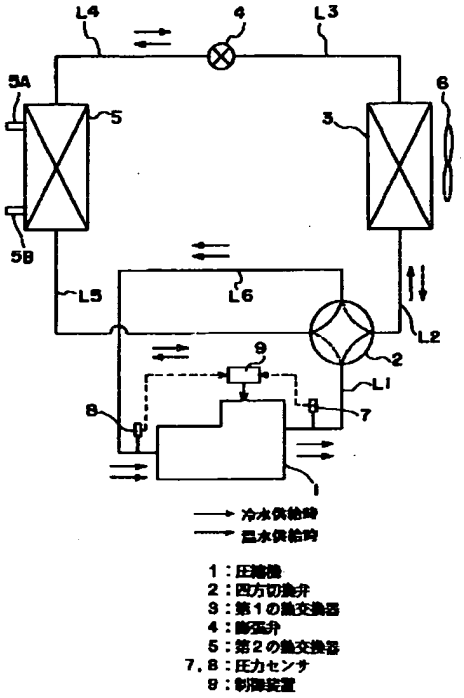
(54)【発明の名称】　ヒートポンプ式熱供給装置

(57)【要約】
【課題】　四方切換弁を適正に切り換えることが可能なヒートポンプ式熱供給装置を提供する。
【解決手段】　圧縮機１、第１の熱交換器３、減圧器４、第２の熱交換器５及び四方切換弁２が順次接続され冷凍サイクルを構成している。冷媒が第１の熱交換器３、減圧器４、第２の熱交換器５の順に流れると第２の熱交換器２を通流する流体が冷却され、逆に第２の熱交換器５、減圧器４、第１の熱交換器３の順に流れると前記流体が加温される。このような熱供給装置において、圧縮機１の吐出側圧力と吸込側圧力を検出する圧力センサ７，８と、圧力センサ７，８から信号を取り込んで圧縮機１の吐出側と吸込側との差圧を演算するとともに、四方切換弁２の切換の際に、差圧が適正範囲に入っているか否かを判定し、適正範囲外の場合は、圧縮機１の吐出量を変化させ差圧が適正値範囲内に入ってから四方切換弁２の切換を行う制御装置９とを設ける。



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【特許請求の範囲】

【請求項1】　圧縮機、第1の熱交換器、減圧器、第2の熱交換器、及び四方切換弁が順次接続された冷凍サイクルを備え、前記第1の熱交換器は該熱交換器外側を流れる空気と前記冷凍サイクル内を循環する冷媒との間で熱交換を行い、前記第2の熱交換器は該熱交換器内を通流する流体と前記冷媒との間で熱交換を行って、前記四方切換弁を切り換えて、前記冷媒を前記第1の熱交換器、前記減圧器および前記第2の熱交換器の順に流したときに前記流体が冷却されて供給され、前記四方切換弁を逆に切り換えて、前記冷媒を前記第2の熱交換器、前記減圧器および前記第1の熱交換器の順に流したときに前記流体が加温されて供給されるヒートポンプ式熱供給装置において、

前記圧縮機の吐出側圧力と吸込側圧力を検出する圧力検出手段と、

前記圧力検出手段から検出結果を取り込んで前記圧縮機の吐出側圧力と吸込側圧力との差圧を演算するとともに、前記四方切換弁を切り換える際に、前記差圧が予め設定された適正範囲に入っているか否かを判定し、適正範囲外の場合は、前記圧縮機の吐出量を変化させ前記差圧が適正値範囲内に入ってから前記四方切換弁の切換を行う制御手段と、を備えたことを特徴とするヒートポンプ式熱供給装置。

【請求項2】　圧縮機、第1の熱交換器、減圧器、第2の熱交換器、及び四方切換弁が順次接続された冷凍サイクルを備え、前記第1の熱交換器は該熱交換器外側を流れる空気と前記冷凍サイクル内を循環する冷媒との間で熱交換を行い、前記第2の熱交換器は該熱交換器内を通流する流体と前記冷媒との間で熱交換を行って、前記四方切換弁を切り換えて、前記冷媒を前記第1の熱交換器、前記減圧器および前記第2の熱交換器の順に流したときに前記流体が冷却されて供給され、前記四方切換弁を逆に切り換えて、前記冷媒を前記第2の熱交換器、前記減圧器および前記第1の熱交換器の順に流したときに前記流体が加温されて供給されるヒートポンプ式熱供給装置において、

前記圧縮機の吐出側圧力と吸込側圧力を検出する圧力検出手段と、

前記圧力検出手段から検出結果を取り込んで前記圧縮機の吐出側圧力と吸込側圧力との差圧を演算するとともに、前記四方切換弁を切り換える際に、前記差圧が予め設定された適正範囲に入っているか否かを判定し、適正範囲の上限値を越えている場合は前記圧縮機の吐出量を減少させ、適正範囲の下限値未満の場合は前記圧縮機の吐出量を増加させて、前記差圧が適正値範囲内に入ってから前記四方切換弁の切換を行う制御手段と、を備えたことを特徴とするヒートポンプ式熱供給装置。

【請求項3】　請求項1又は2に記載のヒートポンプ式熱供給装置において、

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前記適正範囲は、前記差圧に応じて定まる前記四方切換弁の切換回数の寿命特性から決定されることを特徴とするヒートポンプ式熱供給装置。

【請求項4】　請求項1又は2に記載のヒートポンプ式熱供給装置において、

前記制御手段は、前記圧縮機の吐出量を減少もしくは増加させても前記差圧が適正範囲内に入らない場合は、前記圧縮機を停止させるとともに警報表示することを特徴とするヒートポンプ式熱供給装置。

【請求項5】　請求項4に記載のヒートポンプ式熱供給装置において、

前記制御手段は、前記差圧が適正範囲に入ったら、前記圧縮機を再起動させることを特徴とするヒートポンプ式熱供給装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明はヒートポンプ式熱供給装置に係り、特に、冷水および温水を空気調和装置等に切り換えて供給することのできるヒートポンプ式熱供給装置に関する。

【0002】

【従来の技術】ヒートポンプ式熱供給装置には空気側熱交換器、減圧器および水側熱交換器が設けられ、空気側熱交換器は冷媒と外気との間で熱交換を行い、水側熱交換器は冷媒と内部を通流する水との間で熱交換を行うようになっている。そして、圧縮機からの冷媒を室外側熱交換器、減圧器および室内側熱交換器の順に流すと、水側熱交換器内を通流する水は冷却され冷水として供給される。また、逆に圧縮機からの冷媒を室内側熱交換器、減圧器および室外側熱交換器の順に流すと、水側熱交換器内を通流する水は加温され温水として供給される。冷水にするか温水にするかは、圧縮機の吐出側配管に取り付けられた四方切換弁を切り換えることにより行われる。

【0003】ところで、四方切換弁を切り換えた際に、四方切換弁が正常に切り換わらないで弁体が中間位置で止まったりしていると、装置の運転を正常に行うことができず、運転を停止せざるを得なくなる。

【0004】空気調和機についての技術であるが、例えば特開平8-128749号公報には、四方切換弁を切り換えた際に、その切換前後の配管温度を検出して切換前後の温度差を見ることにより、四方切換弁が正常に切り換わったか否かを判定することが提案されている。しかし、四方切換弁が正常に切り換わったか否かを単に判定するだけでは、正常に切り換わっていない場合は、正常な運転を継続できないことになり、結局、空気調和装置の運転を停止させなければならない。

【0005】そこで、特開平5-322355号公報には、四方切換弁の弁体が中間位置で止まるのを防止するようにした空気調和機が提案されている。この空気調和

機においては、四方切換弁は圧縮機の吐出側と吸込側との圧力差を利用して冷媒の流れを変えるものであり、また圧縮機の吐出側と吸込側間には四方切換弁をバイパスしてバイパス回路が設けられている。そして、バイパス回路には開閉弁が取り付けられており、暖房運転時に圧縮機の起動と同時にこの開閉弁を開けると、四方切換弁にかかる圧力差が小さくなって四方切換弁の弁体が中間位置に止まってしまうので、前記開閉弁を１０秒間遅らせてから開けるようにして、弁体が中間位置に止まるのを防止している。

【０００６】

【発明が解決しようとする課題】ここで、上記のように開閉弁を１０秒間遅らせてから開けることをヒートポンプ式熱供給装置に適用しても、四方切換弁の動作不良を完全に無くすことはできない。すなわち、起動時には圧縮機の吐出側と吸込側との圧力差に大きなバラツキがあるので、開閉弁を１０秒間遅らせてから開けるようにしても、四方切換弁が正常に動作するとは限らず、中間位置に止まってしまう可能性が大きい。

【０００７】また、上述のように圧縮機の吐出側と吸込側との圧力差に大きなバラツキがあると、四方切換弁の切換時に弁体に大きな力が加わって、弁体が割れてしまう恐れもある。

【０００８】本発明の目的は、四方切換弁を適正に切り換えることのできるヒートポンプ式熱供給装置を提供することにある。

【０００９】

【課題を解決するための手段】上記目的を達成するために、本発明は、圧縮機、第１の熱交換器、減圧器、第２の熱交換器、及び四方切換弁が順次接続された冷凍サイクルを備え、第１の熱交換器は該熱交換器外側を流れる空気と冷凍サイクル内を循環する冷媒との間で熱交換を行い、第２の熱交換器は該熱交換器内を通流する流体と前記冷媒との間で熱交換を行って、四方切換弁を切り換えて、前記冷媒を第１の熱交換器、減圧器および第２の熱交換器の順に流したときに前記流体が冷却されて供給され、四方切換弁を逆に切り換えて、前記冷媒を第２の熱交換器、減圧器および第１の熱交換器の順に流したときに前記流体が加温されて供給されるヒートポンプ式熱供給装置において、圧縮機の吐出側圧力と吸込側圧力を検出する圧力検出手段と、圧力検出手段から検出結果を取り込んで圧縮機の吐出側圧力と吸込側圧力との差圧を演算するとともに、四方切換弁を切り換える際に、前記差圧が予め設定された適正範囲に入っているか否かを判定し、適正範囲外の場合は、圧縮機の吐出量を変化させ前記差圧が適正値範囲内に入ってから四方切換弁の切換を行う制御手段と、を備えたことを特徴としている。

【００１０】上記構成によれば、四方切換弁を切り換える際に、制御手段は、圧縮機の吐出圧力と吸込側圧力との差圧が予め設定された適正範囲に入っているか否かを判定し、適正範囲に入っていれば直ちに四方切換弁の切換を行うが、適正範囲外の場合、圧縮機の吐出量を変化させて差圧が適正値範囲内に入ってから、四方切換弁の切換を行う。これにより、四方切換弁に大きな圧力差が加わるのを回避できるので、弁体に割れや損傷が発生するのを防ぐことができる。さらに、圧力差が小さすぎて四方切換弁の弁体が中間位置で止まってしまうことも防ぐことができる。

【００１１】実際に、制御手段は、適正範囲の上限値を越えている場合は圧縮機の吐出量を減少させ、差圧が適正範囲の下限値未満の場合は圧縮機の吐出量を増加させて、差圧が適正値範囲内に入ってから四方切換弁の切換を行うよう制御する。

【００１２】適正範囲は、差圧に応じて定まる四方切換弁の切換回数の寿命特性から決定される。

【００１３】また、本発明では、圧縮機の吐出量を減少もしくは増加させても前記差圧が適正範囲内に入らない場合は、圧縮機を停止させるとともに警報表示するよう構成されている。この場合、差圧が適正範囲に入ったら、圧縮機を再起動するようにする。

【００１４】さらに、四方切換弁を切り換えた後に、圧力検出手段から検出結果を取り込んで圧縮機の吐出側圧力と吸込側圧力との差圧を演算し、その差圧が異常値の場合は、圧縮機を停止させるよう構成することもできる。この場合、圧縮機を停止させて所定時間経過後に、圧縮機を再起動させるとともに前記差圧を演算し、その差圧が異常値の場合は圧縮機を停止させる。また、圧縮機の起動と停止を所定回数繰り返したとき、警報表示を行うようにする。

【００１５】

【発明の実施の形態】以下、本発明の実施の形態を図面に従って説明する。

（実施の形態１）図１は本発明に係るヒートポンプ式熱供給装置の構成図である。図に示すように、圧縮機１、四方切換弁２、第１の熱交換器３、膨張弁４、第２の熱交換器５、および四方切換弁２が順次接続されて冷凍サイクルが形成されている。すなわち、圧縮機１の吐出側は冷媒流路Ｌ１を介して四方切換弁２に接続され、四方切換弁２は冷媒流路Ｌ２を介して第１の熱交換器３に、第１の熱交換器３は冷媒流路Ｌ３を介して膨張弁４にそれぞれ接続されている。また、膨張弁４は冷媒流路Ｌ４を介して第２の熱交換器５に、第２の熱交換器５は冷媒流路Ｌ５を介して四方切換弁２に、四方切換弁２は冷媒流路Ｌ６を介して圧縮機１の吸込側にそれぞれ接続されている。

【００１６】第１の熱交換器３は熱源側の熱交換器で、冷却ファン６によって空冷される。また第２の熱交換器５は利用側の熱交換器で、流入管５Ａおよび流出管５Ｂが取り付けられ、流入管５Ａから流入した水が内部を通流し、その後、流出管５Ｂから流出する。

【００１７】上記冷凍サイクル内は冷媒が循環し、第２の熱交換器５内を通流する水を冷却する運転（以下、冷水供給運転という）時には冷媒は図の実線矢印のように流れ、加温する運転（以下、温水供給運転という）時には冷媒は図の破線矢印のように流れる。また四方切換弁２は、冷媒の流れる流路が冷水供給運転時には実線のように、温水供給運転時には破線のようにそれぞれ切り換えられる。

【００１８】また、冷媒流路Ｌ１には圧縮機１の吐出側冷媒圧力を検出する圧力センサ７が、冷媒流路Ｌ６には圧縮機１の吸込側冷媒圧力を検出する圧力センサ８がそれぞれ設けられ、これら圧力センサ７，８での検出信号が入力される制御装置９が設置されている。

【００１９】上記構成において、冷水供給運転時には、圧縮機１で圧縮された高温高圧のガス冷媒は、冷媒流路Ｌ１を介して四方切換弁２に導かれ、この四方切換弁２を実線の流路に沿って流れた後、冷媒流路Ｌ２を介して第１の熱交換器３に導かれる。第１の熱交換器３において、高温高圧のガス冷媒は冷却ファン６によって送風される空気と熱交換して凝縮され、高温高圧の液冷媒となる。その高温高圧の液冷媒は冷媒流路Ｌ３を介して膨張弁４に導かれ、この膨張弁４によって減圧されて低温低圧の二相冷媒となり、さらに冷媒流路Ｌ４を介して第２の熱交換器５に導かれる。そして第２の熱交換器５において、低温低圧の二相冷媒は、第２の熱交換器５内を通流する水と熱交換して、その水を冷却する。これにより、第２の熱交換器５からは冷水を得ることができる。

【００２０】第２の熱交換器５で水と熱交換した低温低圧の二相冷媒は蒸発して低温低圧のガス冷媒となり、冷媒流路Ｌ５を介して四方切換弁２に導かれ、この四方切換弁２を通過後に、冷媒流路Ｌ６を介して圧縮機１に戻され、圧縮機１で再び圧縮される。

【００２１】温水供給運転時には、圧縮機１で圧縮された高温高圧のガス冷媒は、冷媒流路Ｌ１を介して四方切換弁２に導かれ、この四方切換弁２を破線の流路に沿って流れた後、冷媒流路Ｌ５を介して第２の熱交換器５に導かれる。第２の熱交換器５において、高温高圧のガス冷媒は第２の熱交換器５内を通流する水と熱交換して、その水を加温する。これにより、第２の熱交換器５からは温水を得ることができる。

【００２２】第２の熱交換器５で水と熱交換した高温高圧のガス冷媒は凝縮して高温高圧の液冷媒となる。その高温高圧の液冷媒は冷媒流路Ｌ４を介して膨張弁４に導かれ、この膨張弁４によって減圧されて低温低圧の二相冷媒となり、さらに冷媒流路Ｌ３を介して第１の熱交換器３に導かれる。第１の熱交換器３において、低温低圧の二相冷媒は冷却ファン６によって送風される空気と熱交換して蒸発し、低温低圧のガス冷媒となる。そして、その低温低圧のガス冷媒は冷媒流路Ｌ２を介して四方切換弁２に導かれ、この四方切換弁２を通過後、冷媒流路Ｌ６を介して圧縮機１に戻され、圧縮機１で再び圧縮される。

【００２３】図２および図３は四方切換弁２の構成とその駆動機構で、図２は冷水供給運転時の状態を、図３は温水供給運転時の状態をそれぞれ示している。図２および図３に示すように、四方切換弁２には流路接続部２Ａ，２Ｂ，２Ｃ，２Ｄが設けられ、流路接続部２Ａは冷媒流路Ｌ１に、流路接続部２Ｂは冷媒流路Ｌ５に、流路接続部２Ｃは冷媒流路Ｌ６に、流路接続部２Ｄは冷媒流路Ｌ２にそれぞれ接続されている。また、四方切換弁２には、その内部に断面半円状の弁体２Ｅが移動自在に設けられ、この弁体２Ｅは、その両側に配置されたピストン２Ｆ，２Ｇに連結され、ピストン２Ｆ，２Ｇが四方切換弁２の内部を図の左右方向に移動すると、それに連動して左右方向に移動する。これによって、図２のように流路接続部２Ａを流路接続部２Ｄに、流路接続部２Ｃを流路接続部２Ｂに接続することができ、また、図３のように流路接続部２Ａを流路接続部２Ｂに、流路接続部２Ｃを流路接続部２Ｄに接続することができる。

【００２４】また、流路切換制御弁１０が設けられ、この流路切換制御弁１０を切換操作して流路接続部２Ａ内の圧力を四方切換弁２の圧力室２Ｈもしくは圧力室２Ｉに、または流路接続部２Ｃ内の圧力を圧力室２Ｈもしくは圧力室２Ｉに伝達することにより、ピストン２Ｆ，２Ｇは四方切換弁２の内部を図の左右方向に移動する。

【００２５】冷水供給運転時には、流路切換制御弁１０が図２のように切り換えられる。流路接続部２Ａには圧縮機１によって圧縮された高温高圧のガス冷媒が、流路接続部２Ｃには圧縮機１によって吸引される低温低圧のガス冷媒が流れているので、圧力室２Ｉは高圧側に、圧力室２Ｈは低圧側となって、ピストン２Ｆ，２Ｇは図の左方向に押され弁体２Ｅも同方向に移動する。これによって、高温高圧のガス冷媒は流路接続部２Ａから流路接続部２Ｄへと流れ、低温低圧のガス冷媒は流路接続部２Ｂから流路接続部２Ｃへと流れる。

【００２６】温水供給運転時には、流路切換制御弁１０が図３のように切り換えられる。この場合は、圧力室２Ｉは低圧側に、圧力室２Ｈは高圧側となって、ピストン２Ｆ，２Ｇは図の右方向に押され弁体２Ｅも同方向に移動する。これによって、高温高圧のガス冷媒は流路接続部２Ａから流路接続部２Ｂへと流れ、低温低圧のガス冷媒は流路接続部２Ｄから流路接続部２Ｃへと流れる。

【００２７】図４は、本実施の形態におけるヒートポンプ式熱供給装置の動作フローチャートを示している。圧縮機１は吐出量を５０％、７５％、１００％と段階的に切り換える機能を備えたものである。ここで、冷凍サイクルを冷水供給運転から温水供給運転、もしくは温水供給運転から冷水供給運転に切り換える際に、圧縮機１の吐出側圧力Ｐｄを圧力センサ７により検出し、吸込側圧力Ｐｓを圧力センサ８により検出する。圧力センサ７，

８での検出信号は制御装置９に入力され、制御装置９は、入力された検出信号に基づいて差圧ΔＰ＝Ｐｄ－Ｐｓを演算する。そして、制御装置９は差圧ΔＰが適正範囲に入っているか否か判定し、差圧ΔＰが０．０７５ＭＰａを越えている場合は、圧縮機１の吐出量を７５％に減少させる。その結果、熱交換器３，５の伝熱面積に余裕ができ、吐出側圧力Ｐｄが低下し、吸込側圧力Ｐｓが上昇して、差圧ΔＰは小さくなる。そして所定時間経過後、再度、差圧ΔＰを演算し、０．０７５ＭＰａ以下であれば四方切換弁２を切り換える。まだ０．０７５ＭＰａを越えている場合は圧縮機１の吐出量を５０％に減少させて差圧ΔＰを小さくし、０．０７５ＭＰａ以下になれば四方切換弁２を切り換える。

【００２８】一方、差圧ΔＰが０．０３５ＭＰａ未満の場合は、圧縮機１の吐出量を７５％、１００％と増加させることにより差圧ΔＰを増加させ、０．０３５ＭＰａ以上となれば四方切換弁２を切り換える。

【００２９】なお、圧縮機１の吐出量を減少もしくは増加させても、差圧ΔＰが０．０３５ＭＰａ≦ΔＰ≦０．０７５ＭＰａの範囲内に入らない場合は、圧縮機１を停止させるとともに警報表示する。

【００３０】また、四方切換弁２を切り換えた後の差圧ΔＰを演算し、その差圧ΔＰが異常値、例えば０～０．０２ＭＰａの場合は、四方切換弁２の弁体が中間位置に停止、もしくは弁体の切り換え不良と判断し、冷凍サイクルの運転を停止する。

【００３１】その停止から所定時間経ったら、再運転の再開を行い、差圧ΔＰが０．０２ＭＰａを越えていれば運転を継続し、０～０．０２ＭＰａの場合は運転を停止させる。そして、運転の再開・停止を所定回数を繰り返したときは、四方切換弁２に異常があるとの警報表示を行い、冷凍サイクル運転を完全停止させる。

【００３２】上記のように、本実施の形態では、差圧ΔＰが０．０３５ＭＰａ≦ΔＰ≦０．０７５ＭＰａの範囲内で、四方切換弁２を切り換えるよう圧縮機１の吐出量を調整するとともに、四方切換弁２を切り換えた後の差圧ΔＰが異常値の場合、運転を停止させ、所定回数再運転をした後、警報表示して運転を停止させる。

【００３３】図５は、四方切換弁の動作時差圧ΔＰと切換回数による寿命との関係を示している。図から分かるように、差圧ΔＰが大きければ、四方切換弁は切換回数が小さくても故障しやすく、寿命が低下する。逆に、差圧ΔＰが小さければ、四方切換弁は切換回数が大きくても故障しにくく、長寿命化となる。そこで、本実施の形態では、四方切換弁の機械的、強度的寿命特定を鑑み、適正な差圧範囲で四方切換弁の切換を行うよう制御する。

【００３４】本実施の形態によれば、四方切換弁２に加わる差圧を制御することにより、四方切換弁２を切り換える際に弁体には適正な差圧が加えられるため、弁体の割れ、破損等を防止することができ、四方切換弁２の長寿命化を図ることができる。

【００３５】また、四方切換弁２を切り換えた後の差圧を求めることにより、四方切換弁２の弁体が中間位置に停止しているか否かを検知することができ、もし弁体が中間位置に停止していれば運転を停止させ、所定時間経ってから運転を自動的に再開することで冷凍サイクルが保護され、システム全体の信頼性向上につながる。

【００３６】なお、本実施の形態では差圧ΔＰが０．０３５ＭＰａ≦ΔＰ≦０．０７５ＭＰａの範囲内で四方切換弁２の切換を行うようにしたが、どの位の切換回数を寿命とするかによって差圧ΔＰを変更することができる。

【００３７】また、第２の熱交換器５内を通流する流体は水に限らず、他の流体であってもよい。

【００３８】（実施の形態２）図６は、本発明の実施の形態２を示している。本実施の形態では、圧縮機１は所定の吐出量を連続的に変えることができるように構成されたものである。他の構成は、実施の形態１と同じである。すなわち、冷凍サイクルの構成は図１に示したものと同じであり、また四方切換弁２の構成も図２および図３に示したものと同じである。

【００３９】本実施の形態では、制御装置９は四方切換弁２を切り換える差圧ΔＰを演算し、差圧ΔＰが０．０７５ＭＰａを越えている場合は、圧縮機１の吐出量を所定量、例えば５％減少させる（なお、所定量は任意の値である）。そして、所定時間経過後に、再度、差圧ΔＰを演算し、０．０７５ＭＰａを越えていれば、同様に吐出量を５％減少させ、差圧ΔＰが０．０７５ＭＰａ以下となるよう調整する。

【００４０】また、差圧ΔＰが０．０３５ＭＰａ未満の場合も、同様に圧縮機１の吐出量を所定量増加させ、差圧ΔＰが０．０３５ＭＰａ以上となれば四方切換弁２を切り換える。

【００４１】本実施の形態によれば、四方切換弁１に加わる差圧を検知し、圧縮機１の吐出量を所定量変化させることにより、実施の形態１と同様に、四方切換弁２の弁体の割れや破損の防止、並びに弁体が中間位置に停止するのを防止できる。さらに、本実施の形態では、圧縮機１からの吐出量が所定量で連続的に制御されるので、減容遅れによる必要以上の容量制限を加える必要がない。つまり、冷水または温水を供給する能力低下を最小限に抑えることができる。

【００４２】（実施の形態３）次に、図７を用いて実施の形態３について説明する。圧縮機１は、実施の形態１の場合と同様、吐出量を５０％、７５％、１００％と段階的に切り換える機能を備えたものである。ここで、温水供給運転から除霜運転に切り換える際に、圧縮機１の吐出側圧力Ｐｄを圧力センサ７により検出し、吸込側圧力Ｐｓを圧力センサ８により検出する。圧力センサ７，

８での検出信号は制御装置９に入力され、制御装置９は差圧ΔＰ＝Ｐｄ－Ｐｓを演算する。そして、制御装置９は差圧ΔＰがΔＰmax以下であるか否か判定し、ΔＰmaxを越えている場合は、圧縮機１の吐出量を変化させる（例えば、吐出量を７５％に減少させる）。ある一定時間経過後、再度、差圧ΔＰを演算し、ΔＰmax以下であれば四方切換弁２を切り換える。まだ、ΔＰmaxを越えていれば、圧縮機１の吐出量を更に変化させる（例えば、吐出量を５０％に減少させる）。そして、ΔＰmax以下になれば四方切換弁２を切り換える。

【００４３】また、四方切換弁２を切り換えた後の差圧ΔＰを演算し、その差圧ΔＰが異常値ΔＰmin未満の場合は、四方切換弁２の弁体が中間位置に停止、もしくは弁体の切り換え不良と判断されるので、冷凍サイクルの運転（すなわち、圧縮機１の運転）を停止する。

【００４４】その停止から所定時間経ったら、再運転の再開を行い、差圧ΔＰがΔＰmin以上であれば運転を継続し、ΔＰmin未満であれば運転を停止させる。そして、運転の再開・停止を所定回数を繰り返したとき、四方切換弁２に異常があるとの警報表示を行い、冷凍サイクル運転を完全停止させる。なお、ΔＰmaxおよびΔＰminの具体例は図５の示してある。

【００４５】上記のように本実施の形態では、差圧ΔＰをΔＰmin～ΔＰmaxの範囲内で四方切換弁を切り換えるよう圧縮機の吐出量を調整し、差圧ΔＰが異常値の場合、運転を停止させ、所定回数再運転をした後、警報表示して運転を停止させる。本実施の形態によれば、実施の形態１と同様な効果を得ることができる。

【００４６】（実施の形態４）次に、図８を用いて実施の形態４について説明する。圧縮機１は、実施の形態２と同様に、所定の吐出量を連続的に変えることのできるようになっている。

【００４７】本実施の形態では、制御装置９は四方切換弁２を切り換える差圧ΔＰを演算し、差圧ΔＰがΔＰmaxを越えている場合は、圧縮機１の吐出量を所定量に変化させ、例えば５％減少させる。そして、所定時間経過後に、再度、差圧ΔＰを演算し、ΔＰmax以下であれば四方切換弁２を切り換え、ΔＰmaxを越えていれば圧縮機１の吐出量を所定量変化（減少）させて差圧ΔＰを小さくし、ΔＰmax以下になるよう繰り返し調整する。本実施の形態によれば、実施の形態２と同様な効果を得ることができる。

【００４８】

【発明の効果】以上説明したように、本発明によれば、四方切換弁を切り換える差圧を演算し、適正な差圧状態にて四方切換弁を切り換えることにより、弁体の割れや破損を防止でき、また弁体が中間位置に停止することも防止できる。その結果、四方切換弁の信頼性が向上して、長寿命化を図ることができる。

【図面の簡単な説明】

【図１】本発明に係るヒートポンプ式熱供給装置の構成図である。

【図２】四方切換弁の冷水供給運転時の状態を示した図である。

【図３】四方切換弁の温水供給運転時の状態を示した図である。

【図４】本発明の実施の形態１による動作フローチャートである。

【図５】四方切換弁の寿命線図である。

【図６】本発明の実施の形態２による動作フローチャートである。

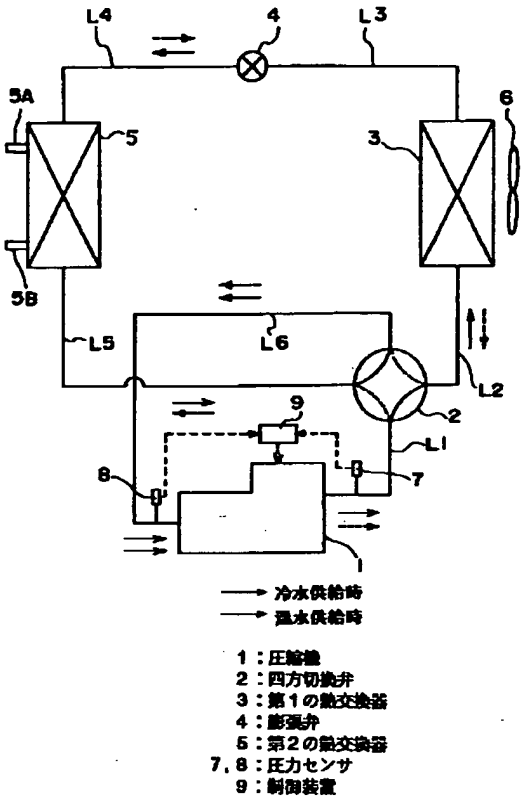
【図７】本発明の実施の形態３による動作フローチャートである。

【図８】本発明の実施の形態４による動作フローチャートである。

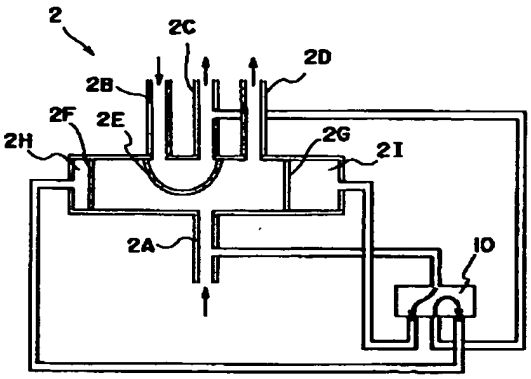
【符号の説明】

１　圧縮機
２　四方切換弁
３　第１の熱交換器
４　膨張弁
５　第２の熱交換器
６　冷却ファン
７，８　圧力センサ（圧力検出手段）
９　制御装置（制御手段）
１０　流路切換制御弁

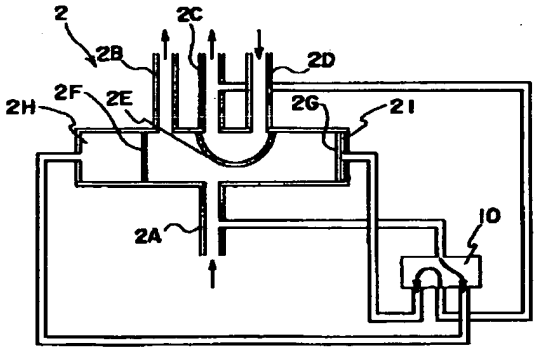
【図1】


L4
4
L3
5A
5
6
3
5B
L5
L6
L2
2
9
L1
8
7
1
冷水供給時
温水供給時
1：圧縮機
2：四方切換弁
3：第1の熱交換器
4：膨張弁
5：第2の熱交換器
7，8：圧力センサ
9：制御装置

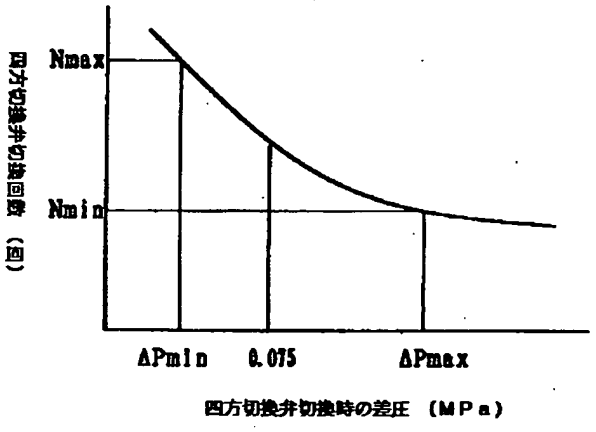
【図2】


2
2C
2D
2B
2F
2E
2H
2G
2I
2A
10

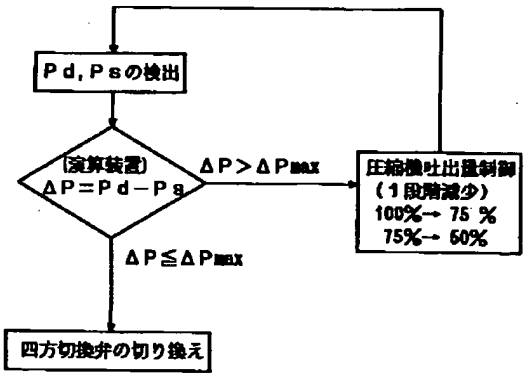
【図3】


2
2C
2B
2D
2F
2E
2H
2G
2I
2A
10

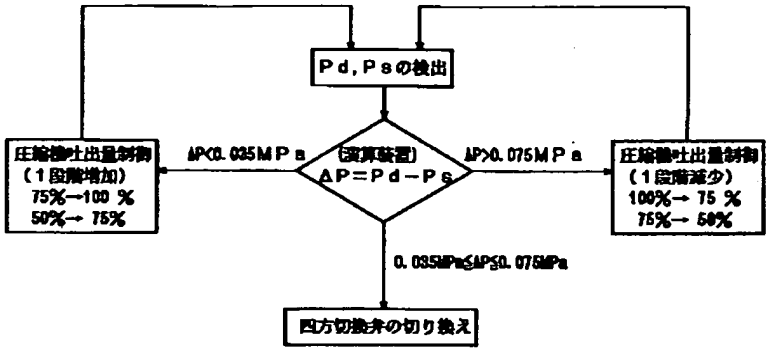
【図5】


Nmax
Nmin
四方切換弁切換回数（回）
ΔPmin
0.075
ΔPmax
四方切換弁切換時の差圧（MPa）

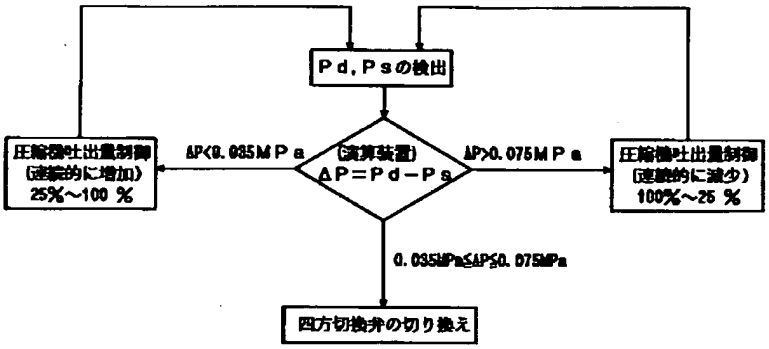
【図7】


Pd，Psの検出
（演算装置）
ΔP＝Pd−Ps
ΔP＞ΔPmax
圧縮機吐出量制御
（1段階減少）
100%→ 75 %
75%→ 50%
ΔP≦ΔPmax
四方切換弁の切り換え

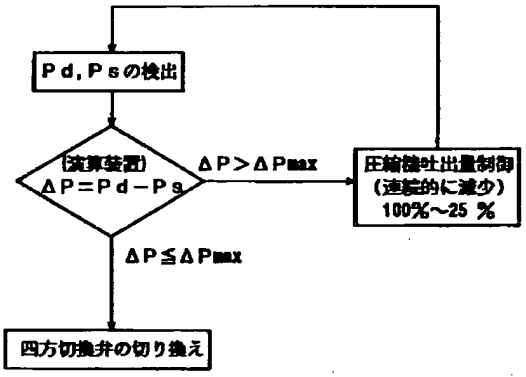
【図4】



【図6】



【図8】



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